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Attorney's Docket No. 67,200-473

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Jane-Bai Lai
Serial No.: 09/941,356
Filed: Aug. 29, 2001
For: Method of Wet Etching Low Dielectric Constant Materials

Group Art Unit: 1765 ✓
Examiner: Umez Eronini, Lynette T.

Commissioner for Patents
Alexandria, VA 22313

TRANSMITTAL OF APPEAL BRIEF (PATENT APPLICATION-37 CFR 192)

1. Transmitted herewith, in triplicate, is the APPEAL BRIEF in this application, with respect to the Notice of Appeal Filed on Oct. 30, 2003.

NOTE: "The Appellant shall, within 2 months from the date of the notice of appeal under § 1.191(a) or within the time allowed for response to the action appealed from, if such time is later, file a brief in "triplicate", 37 C.F.R. 1.192(a) [emphasis added].

2. STATUS OF APPLICANT
This application is on behalf of:
X other than a small entity.
_____ a small entity.

A verified statement:
_____ is attached.
_____ was already filed.

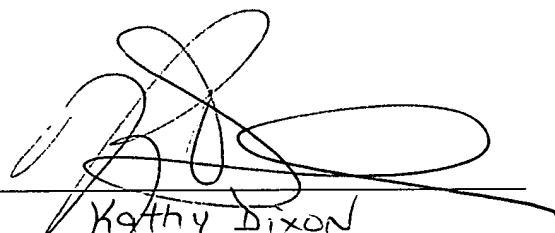
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Kathy Dixon

Dated: Dec. 30/03

4. EXTENSION OF TERM

NOTE: The time periods set forth in 37 CFR 1.192(a) are subject to the provision of ☐ 1.136 for patent applications. 37 CFR 1.191(d). See also Notice of November 5, 1985 (1060 O.G. 27).

The proceedings herein are for a patent application and the provisions of 37 CFR 1.136 apply:

(complete (a) or (b), as applicable)

- (a) ☐ Applicant petitions for an extension of time under 37 CFR 1.136
(fees: 37 CFR 1.17(a)-(d) for the total number of months checked below:

	Extension (months)	Fee for other than small entity	Fee for small entity
<input type="checkbox"/>	one month	\$ 110.00	\$ 55.00
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<input type="checkbox"/>	three months	\$ 950.00	\$475.00
<input type="checkbox"/>	four months	\$1,480.00	\$740.00

Fee: \$ _____

If an additional extension of time is required, please consider this a petition therefor.

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- ☐ An extension for _____ months has already been secured, and the fee paid therefor of \$ _____ is deducted from the total fee due for the total months of extension now requested.

Extension fee due with this request: \$ _____

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- (b) ☐ Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

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A handwritten signature in black ink, appearing to be 'Randy W. Tung', written over a horizontal line.

Signature of Attorney

Registration No. 31,311

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.: 09/941,356

Art Unit: 1765

Applicant: Jane-Bai Lai

Filed: August 29, 2001

Title: METHOD OF WET ETCHING LOW DIELECTRIC CONSTANT MATERIALS

Examiner: Umez Eronini, Lynette T.

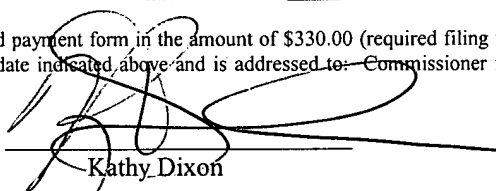
Attorney Docket No. 67,200-473

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Kathy Dixon

APPEAL BRIEF

Sir:

This is Appellants' Appeal Brief in support of reversing the Examiner's rejection of claims 8-22 and 24 in the final Office Action of July 30, 2003.

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ISSUE III. Whether Claims 9 And 17 Have Been Properly Rejected Under 35 USC 103(a) As Being Unpatentable Over Buynoski In View Of Weber As Applied To Claim 8 Above, And Further In View Of Asam

ISSUE IV. Whether Claims 10, 11, 15, 19 and 22 Have Been Properly Rejected Under 35 USC 103(a) As Being Unpatentable Over Buynoski In View Of Weber As Applied To Claim 8 Above, and Further In View Of Tobben Et Al

ISSUE V. Whether Claim 16 Has Been Properly Rejected Under 35 USC 103(a) As Being Unpatentable Over Buynoski In View Of Weber As Applied To Claim 8 Above, and Further In View Of Gardner

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ISSUE VII. Whether Claim 21 Has Been Properly Rejected
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The Negative Limitation Is Actually In Appellants'
Specification

Weber And Buynoski Fail To Disclose The Claimed
Invention, And Actually Teach Away From The Claimed
Invention

Asam Does Not Point Out Which Is The “Result Effect Variable”

The Rejection Fails To Indentify Sufficient Modivation To Substitute
Different Dielectric Layers, And Tobben Et Al Teach Away From
The Claimed Invention

Gardner Does Not Overcome The Deficiencies Or The Teaching Away
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Lee, Et Al. Fails To Disclose The Use Of A Low Dielectric Constant
Dielectric Layer And The Problem Associated With Preparing A Specimen
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I. REAL PARTY IN INTEREST

The real party in interest is Taiwan Semiconductor Manufacturing Company.

II. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

III. STATUS OF THE CLAIMS

Claims 8-22 and 24 are pending in the case and all of those claims stand rejected.

IV. STATUS OF THE AMENDMENTS

Appellants' amendment after final was not entered. Appendix I sets forth the claims that were rejected in the final Office Action.

V. SUMMARY OF THE INVENTION

Appellants' invention is a method of etching a semiconductor device having a low dielectric constant dielectric material between two metal interconnect layers. A aqueous solution of HF and HCl is used to do the etching. Unlike prior art aqueous etching systems that are repulsed by low dielectric constant materials (See instant application at page 11, lines 7-8; and the last paragraph of page 17), the present invention does not stop etching on the low dielectric constant material. The present method allows a device to be etched so that multiple layer are clearly visible under a scanning electron microscope. The method is particularly useful for quality control and wafer manufacturing inspection. Otherwise, for low dielectric constant

devices that have been section by FIB, it is often impossible to distinguish among the various interlayer dielectric materials (See page 11, lines 2-3). The various low dielectric constant materials and the weight ratio of HF to HCl in the solution that are recited in the dependent claims are not suggested by the prior art.

VI. ISSUES

The following issues are involved in the appeal.

ISSUE I. WHETHER CLAIMS 8 AND 21 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 112, FIRST PARAGRAPH, FOR FAILING TO COMPLY WITH THE WRITTEN DESCRIPTION REQUIREMENT

ISSUE II. WHETHER CLAIMS 8, 12, 13, 14, 18 AND 20 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER

ISSUE III. WHETHER CLAIMS 9 and 17 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF ASAM

ISSUE IV. WHETHER CLAIMS 10, 11, 15, 19 and 22 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF TOBBEN ET AL

ISSUE V. WHETHER CLAIM 16 HAS BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF GARDNER

ISSUE VI. WHETHER CLAIM 21 HAS BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER

ISSUE VII. WHETHER CLAIM 24 HAS BEEN PROPERLY REJECTED
UNDER 35 USC 103(a) AS UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS
APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF LEE ET AL

VII. GROUPING OF THE CLAIMS

For purposes of this appeal, the claim do not all stand or fall together. The claims stand or fall according to the following separate groupings and are separately patentable by those groups.

GROUP I: Claims 8, 12-14, 16 stand and fall together in this appeal.

GROUP II. Claim 9 is separately patentable.

GROUP III. Claim 10 is separately patentable.

GROUP IV. Claim 11 is separately patentable.

GROUP V. Claim 15 is separately patentable.

GROUP VI. Claim 17 is separately patentable.

GROUP VII. Claim 18 is separately patentable.

GROUP VIII. Claim 19 is separately patentable.

GROUP IX. Claim 20 is separately patentable.

GROUP X. Claim 21 is separately patentable.

GROUP XI. Claim 22 is separately patentable.

GROUP XII. Claim 24 is separately patentable.

The basis upon which these groups and claims are separately patentable is set forth in the argument section of the brief.

VIII. ARGUMENT

Claims 18-22 and 24 are remaining in this application.

ISSUE I. WHETHER CLAIMS 8 AND 21 HAVE BEEN PROPEERLY REJECTED UNDER 35 USC 112, FIRST PARAGRAPH, FOR FAILING TO COMPLY WITH THE WRITTEN DESCRIPTION REQUIREMENT

Claim 8 and 21 were rejected under 35 USC 112, first paragraph, as failing to comply with the written description requirement. The Examiner has taken the position that in claim 8 and 21 the recitation “and so that the etching does not stop on the low dielectric constant material and the dielectric layer is etched” raises new matter, which lacks support from the Specification. The rejection is in error and Appellants respectfully request the Board to reverse the rejection.

THE NEGATIVE LIMITATION IS ACTUALLY IN APPELLANTS’ SPECIFICATION

The Board’s attention is directed to the instant application at the last paragraph, bridging pages 16 and 17, wherein Appellants provide comparative examples of the present invention to the prior art. In the examples, a semiconductor device having eight levels of copper metal interconnect and an interlayer dielectric of $\text{Si}(\text{CH}_3)_x\text{O}_{2-x}$ was sectioned and etched with a solution prepared according to the present invention, including an aqueous solution of HF and HCl. The etched device was analyzed under a scanning electron microscope and all eight levels of copper and dielectric layer were clearly visible. In contrast, as described on page 17, when a similar device was sectioned and etched with a prior art aqueous solution including HCl, the “etch stopped on the low dielectric constant material.” Appellants’ recites substantially the same language in independent claims 8 and 21.

Appellants having described the prior art in their application, are entitled to exclude the prior art in their claims using negative limitations. There is no rule, or law, per se against the use of negative limitations. Ex parte Allwelt, 105 USPQ 133 (BOPAI 1954). The Examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a prima facie case of unpatentability. In re Oetiker, 977 F.2d 1443 (Fed. Cir. 1992). The specification as a whole, including the examples therein, reasonably conveys to a person of ordinary skill in the art that the inventors had possession of the subject matter (negative limitations) in question at the time the present application was filed. Ex parte Park, 30 USPQ2d 1234, 1236 (BPAI 1994). To date, the Examiner has not proffered or pointed to any factual evidence to the contrary. Appellants request the reversal of the rejection of claims 8 and 21 under 35 USC 112.

ISSUE II. WHETHER CLAIMS 8, 12, 13, 14, 18 AND 20 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER

Claims 8, 12, 13, 14, 18 and 20 have been properly rejected under 35 USC 103(a) as being unpatentable over Buynoski in view of Weber. The rejection is in error for the following reasons.

WEBER AND BUYNOSKI FAIL TO DISCLOSE THE CLAIMED INVENTION, AND ACTUALLY TEACH AWAY FROM THE CLAIMED INVENTION

The Examiner maintains that Buynoski teaches providing a semiconductor device having at least two metal interconnect layers having low dielectric constant material between the metal interconnect layers citing column 5, lines 45-59 in Figs. 1-4. The Examiner acknowledges that

Buynoski does not teach etching the device with an aqueous solution of HF and HCl (See page 3 of the final Office Action of July 30, 2003).

The Examiner maintains that Weber teaches that HCl and HCl tend to preferentially etch the interface region between a metal electrode and a substrate such as a polyamide (in maintaining that the polyamide is a low dielectric constant material) citing columns 4, lines 21-24, and maintains that Weber reads on etching a semiconductor device in the aqueous solution of HCl and HF.

However, the Examiner's reading and interpretation of Weber is erroneous, which makes the rejection fatally defective. The Weber teaches anodically etching a metal layer using electrolytes solution including ammonium hydroxide. All of the examples in Weber are directed to this invention. The only exception is the one paragraph cited by the Examiner. However, the Board's attention is respectfully directed to column 4, lines 17-28. Weber states: "Hydrochloric and hydrofluoric acid are volatile electrolytes which are incompatible for use in some applications of the subject invention." Weber states that each of hydrochloric and hydrofluoric are volatile electrolytes. Weber does not teach etching with an aqueous solution of hydrochloric acid and hydrofluoric acid. The Weber states: "hydrochloric acid and hydrofluoric acid tend to preferentially etch the interface region between a metal electrode and a substrate such as polyamide." It is unclear what the "interface region" between the metal electrode and the substrate is, nor is it clear what exactly is etched. Those skilled in the art are left to speculate as to what is actually is etched. Obviousness cannot be predicated on speculation. What is clear, however, is that Weber does not disclose etching a low dielectric constant material with an aqueous solution of hydrochloric acid and hydrofluoric acid. Nor does Weber teach etching a

low dielectric constant material between two metal interconnect layers has called for in claim 8. Applicant maintains that Weber does not teach etching the polyamide layer. At best, even if one would strain to interpret Weber as disclosing etching the polyimide layer, the etching process clearly stops on the polyamide layer. Independent claim 8 as now amended clearly distinguishes over even a strained and speculative interpretation of the disclosure of Weber. Furthermore, since claim 8 is not anticipated under 35 USC 102, Appellants point out the teaching away comments regarding “crazing” made in column 4, lines 26-28. A person of ordinary skill in the art would not be motivated to combine or modify Buynoski in view of Weber in the face of these teaching away comments.

Although Buynosky may teach two metal interconnect layers with a low dielectric constant material therebetween, one cannot ignore the teaching away effect set forth in the paragraph bridging columns 4 and 5, which discloses that a low dielectric constant material (BCB) should be etched with a mixed oxygen-fluorine plasma. As such, Buynosky actually teaches away from etching a low dielectric material with an aqueous solution of hydrochloric acid and hydrofluoric acid. There’s no motivation in any of the references to modify Weber or Buynosky to arrive at applicants claimed invention, nor is there any teaching in the prior art to provide a person of ordinary skill in the art with a reasonable expectation of success if such modification were made. Appellants respectfully request to Board to reverse the Examiner’s rejection.

ISSUE III. WHETHER CLAIMS 9 and 17 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE AND FURTHER IN VIEW OF ASAM

Claims 9 and 17 have been rejected under 35 USC 103 is being unpatentable over Buynoski in view of Weber applied to claim 8 above, and further in view of Asam. The rejection is in error for the following reasons.

ASAM DOES NOT POINT OUT WHICH IS THE “RESULT EFFECT VARIABLE”

Appellants’ above comments regarding Buynoski and Weber are hereby repeated. The Examiner maintains that Asam teaches the etching step may be controlled by regulating etchant concentration. However, since Weber fails to disclose Appellants’ claimed etching solution comprising an aqueous solution of HCl and HF, the references do not identify which of the multiple possible variables is the “result effective variable” to be optimized. Furthermore, the teaching away effects of the numerous references of record cannot be overlooked in hindsight to identify a “result effective variable” and simply conclude that optimization thereof would have been within the skill of a person in the art.

ISSUE IV. WHETHER CLAIMS 10, 11, 15, 19 and 22 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF TOBBEN ET AL

Claims 10, 11, 15, 19 and 22 had been rejected under 35 USC 103 is being unpatentable over Buynoski in view of Weber as applied to claim 8 above, and further in view of Tobben et al. The rejection is in error for the following reason and should be reversed.

THE REJECTION FAILS TO IDENTIFY SUFFICIENT MOTIVATION TO SUBSTITUTE DIFFERENT DIELECTRIC LAYERS, AND TOBBEN ET AL TEACH AWAY FROM THE CLAIMED INVENTION

Appellants comments above regarding Buynoski and Weber are hereby repeated. The Examiner has taken the position that it would have been obvious to modify Buynoski with the methyl silsesquioxane disclosed in Tobben. However, Tobben teaches etching the dielectric layer 112 with a conventional reactive ion etching process, see column 4, lines 48-15. Even if there is motivation to substitute dielectric layers, a person of ordinary skill in the art would not ignore the teaching away statements of Tobben with regard to etching techniques.

ISSUE V. WHETHER CLAIM 16 HAS BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF GARDNER

Claim 16 had been rejected under 35 USC 103 as being unpatentable over Buynoski in view of Weber as applied to claim 8 and further in view of Gardner. The rejection is in error for the following reasons and should be reversed.

GARDNER DOES NOT OVERCOME THE DEFICIENCIES OR TEACHING AWAY EFFECT OF THE OTHER REFERENCES

Appellants comments above regarding Buynoski and Weber are hereby repeated. Although Gardner teaches a variety of low dielectric layers, the addition of this reference cannot overcome the deficiencies of Weber and the teaching away effects of numerous references relied on by the Examiner.

ISSUE VI. WHETHER CLAIM 21 HAS BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER

Independent claim 21 recites “and so that the etching does not stop on the low dielectric constant material and the dielectric layer is etched” in a manner similar to claim 8 and is patentable for the same reasons stated above. Claim 21, by requiring that the etching does not stop on the low dielectric constant material and the dielectric layer is etched, defines over Weber that teaches an etching solution that stops on the dielectric layer. The rejection is in error and should be reversed.

ISSUE VII. WHETHER CLAIM 24 HAS BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF LEE ET AL

Claim 24 had been rejected under 35 USC 103(a) as unpatentable over Buynoski in view of Weber as applied to claim 8 above, and further in view of Lee et al. The rejection is in error and should be reversed for the following reasons.

LEE, ET AL. FAILS TO DISCLOSE THE USE OF A LOW DIELECTRIC CONSTANT DIELECTRIC LAYER AND THE PROBLEM ASSOCIATED WITH PREPARING A SPECIMEN THEREOF FOR VIEW UNDER A SCANNING ELECTRON MICROSCOPE

Lee, et al. U.S. Patent No.6,251,782 discloses a method of preparing a specimen by focused ion beam sectioning for examination under an electron-scanning microscope. The Examiner has focused on Lee, et al. at column 2, lines 52-54, which discloses that “the structure is then etched in a wet etchant such that it may be observed in an SEM for studying the characteristic feature or defect and its reason for being defective.” However, Lee, et al. fails to disclose the use of a low dielectric constant dielectric layer and the problem associated with preparing a specimen thereof for view under a scanning electron microscope. In fact, Lee, et al. fails to disclose any specific etchant for use on the dielectric layer (which is an oxide insulating

layer 44 (see col.6, lines 6-8)). The Board's attention is respectfully directed to the paragraph bridging columns 6 and 7 which states at line 67, that "a suitable wet etchant can be used to etch away the insulating layer, i.e., the oxide layer such that a failed bit of the polished silicon gate and floating gate can be shown." As such, Lee, et al. fails to address the problem of preparing a specimen having a low dielectric layer and analyzing the etched device in a scanning electron microscope as now called for in Appellants claim 24. The Board should reverse the Examiner's rejection of claim 24.

SEPARATE PATENTABILITY

GROUP I: Claims 8, 12-14, 16 stand and fall together in this appeal. The claims of Group I are patentable for the reasons stated above.

GROUP II. Claim 9 is separately patentable. Claim 9 is separately patentable because the prior art does not suggest the recited weight ratio of HF to HCl.

GROUP III. Claim 10 is separately patentable. Claim 10 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material includes -OR groups.

GROUP IV. Claim 11 is separately patentable. Claim 11 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material includes methyloxy groups.

GROUP V. Claim 15 is separately patentable. Claim 15 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material has a dielectric constant less than 3.8.

GROUP VI. Claim 17 is separately patentable. Claim 17 is separately patentable because the prior art does not suggest the recited deionized water and weight ratio of HF to HCl.

GROUP VII. Claim 18 is separately patentable. Claim 18 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material is hydrophobic.

GROUP VIII. Claim 19 is separately patentable. Claim 19 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material includes an organosilicon.

GROUP IX. Claim 20 is separately patentable. Claim 20 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material includes an organic based film.

GROUP X. Claim 21 is separately patentable for the reasons stated above.

GROUP XI. Claim 22 is separately patentable. Claim 22 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material includes $\text{Si}(\text{CH}_3)_x\text{O}_{2-x}$.


GROUP XII. Claim 24 is separately patentable. Claim 24 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the device includes a low dielectric constant material, and analyzing the device in a scanning electron microscope. The prior art does not suggest that the individual layers of a device so etched would be visible under a scanning electron microscope.

IX. CONCLUSION

Claims 18-22 and 24 are remaining in this application. The Examiner's rejection of the claims is in error and should be reversed. The negative limitations used in claims 8 and 21 actually are in Appellants' specification. Weber teaches etch with ammonium hydroxide and does not disclose an aqueous etching solution of HF and HCL. Instead Weber actual teaches that an etching solution of HF or HCl will stop on a low dielectric constant layer. Buynoski teaches away by teaching to etch with mixed oxygen-fluorine plasma. Asam does not identify the "result effect variable" to optimize. The rejection does identify sufficient motivation to substitute dielectric layer of Tobben for that of Buynoski. Tobben also teaches away by etching with a with a conventional reactive ion etching process. Gardner does not overcome the deficiencies or teaching away of the other references. Lee, et al. fails to disclose the use of a low dielectric constant dielectric layer and the problem associated with preparing a specimen thereof for view under a scanning electron microscope.

In view of the above errors in the rejections and Appellants' arguments, Appellants respectfully request that the Board reverse the Examiners' rejection of the claims remaining in the case.

Respectfully submitted



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LIST OF CLAIMS INVOLVED IN THE APPEAL

Claims 1. - 7. (Cancelled)

Claim 8: A method comprising:

providing a semiconductor device having at least two metal interconnect layers and a dielectric layer comprising a low dielectric constant material between the metal interconnect layers;

etching the device in aqueous solution of HF and HCl and so that the etching does not stop on the low dielectric constant material and the dielectric layer is etched.

Claim 9: A method as set forth in claim 8 wherein the weight ratio of HF to HCl in the solution ranges from 1:3 to 4:1.

Claim 10: A method as set forth in claim 8 wherein the low dielectric constant material includes -OR groups wherein R is a hydrocarbon derivative.

Claim 11: A method as set forth in claim 8 wherein the low dielectric constant includes methyloxy groups.

Claim 12: A method as set forth in claim 8 wherein the metal interconnect consists essentially of copper.

Claim 13: A method as set forth in claim 8 wherein the metal interconnect comprises aluminum.

Claim 14: A method as set forth in claim 8 wherein the step of etching the device is carried out by dipping the device in a bath of the aqueous solution of HF and HCl.

Claim 15: A method as set forth in claim 8 wherein the low dielectric constant material has a dielectric constant less than 3.8.

Claim 16: A method as set forth in claim 8 wherein the low dielectric constant material comprises fluorosilicate glass.

Claim 17: A method as set forth in claim 9 wherein the aqueous solution includes deionized water and wherein the weight ratio of the deionized water to either HF or HCl ranges from about 20:1 to 6:5.

Claim 18: A method as set forth in claim 8 wherein the low dielectric constant material is hydrophobic.

Claim 19: A method as set forth in claim 8 wherein the low dielectric constant material comprises an organosilicon.

Claim 20: A method as set forth in claim 8 wherein the low dielectric constant material comprises an organic based film.

Claim 21: A method comprising:

providing a semiconductor device having at least two metal interconnect layers and a dielectric layer comprising a low dielectric constant material between the two metal interconnect layers;

etching the semiconductor device in an aqueous solution of HF and HCl and so that the etching does not stop on the low dielectric constant material and the dielectric layer is etched.

Claim 22: A method as set forth in claim 8 wherein the low dielectric constant material includes $\text{Si}(\text{CH}_3)_x\text{O}_{2-x}$.

Claim 23. (cancelled)

Claim 24: A method as set forth in claim 8 further comprising analyzing the etched device in a scanning electron microscope.



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.: 09/941,356

Art Unit: 1765

Applicant: Jane-Bai Lai

Filed: August 29, 2001

Title: METHOD OF WET ETCHING LOW DIELECTRIC CONSTANT MATERIALS

Examiner: Umez Eronini, Lynette T.

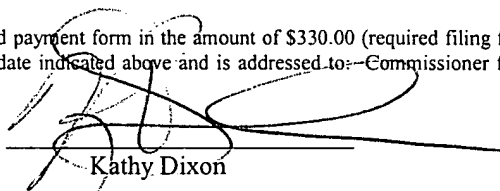
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Kathy Dixon

APPEAL BRIEF

Sir:

This is Appellants' Appeal Brief in support of reversing the Examiner's rejection of claims 8-22 and 24 in the final Office Action of July 30, 2003.

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The Negative Limitation Is Actually In Appellants'
Specification

Weber And Buynoski Fail To Disclose The Claimed
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I. REAL PARTY IN INTEREST

The real party in interest is Taiwan Semiconductor Manufacturing Company.

II. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

III. STATUS OF THE CLAIMS

Claims 8-22 and 24 are pending in the case and all of those claims stand rejected.

IV. STATUS OF THE AMENDMENTS

Appellants' amendment after final was not entered. Appendix I sets forth the claims that were rejected in the final Office Action.

V. SUMMARY OF THE INVENTION

Appellants' invention is a method of etching a semiconductor device having a low dielectric constant dielectric material between two metal interconnect layers. A aqueous solution of HF and HCl is used to do the etching. Unlike prior art aqueous etching systems that are repulsed by low dielectric constant materials (See instant application at page 11, lines 7-8; and the last paragraph of page 17), the present invention does not stop etching on the low dielectric constant material. The present method allows a device to be etched so that multiple layer are clearly visible under a scanning electron microscope. The method is particularly useful for quality control and wafer manufacturing inspection. Otherwise, for low dielectric constant

devices that have been section by FIB, it is often impossible to distinguish among the various interlayer dielectric materials (See page 11, lines 2-3). The various low dielectric constant materials and the weight ratio of HF to HCl in the solution that are recited in the dependent claims are not suggested by the prior art.

VI. ISSUES

The following issues are involved in the appeal.

ISSUE I. WHETHER CLAIMS 8 AND 21 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 112, FIRST PARAGRAPH, FOR FAILING TO COMPLY WITH THE WRITTEN DESCRIPTION REQUIREMENT

ISSUE II. WHETHER CLAIMS 8, 12, 13, 14, 18 AND 20 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER

ISSUE III. WHETHER CLAIMS 9 and 17 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF ASAM

ISSUE IV. WHETHER CLAIMS 10, 11, 15, 19 and 22 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF TOBBEN ET AL

ISSUE V. WHETHER CLAIM 16 HAS BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF GARDNER

ISSUE VI. WHETHER CLAIM 21 HAS BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER

ISSUE VII. WHETHER CLAIM 24 HAS BEEN PRPERLY REJECTED
UNDER 35 USC 103(a) AS UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS
APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF LEE ET AL

VII. GROUPING OF THE CLAIMS

For purposes of this appeal, the claim do not all stand or fall together. The claims stand or fall according to the following separate groupings and are separately patentable by those groups.

GROUP I: Claims 8, 12-14, 16 stand and fall together in this appeal.

GROUP II. Claim 9 is separately patentable.

GROUP III. Claim 10 is separately patentable.

GROUP IV. Claim 11 is separately patentable.

GROUP V. Claim 15 is separately patentable.

GROUP VI. Claim 17 is separately patentable.

GROUP VII. Claim 18 is separately patentable.

GROUP VIII. Claim 19 is separately patentable.

GROUP IX. Claim 20 is separately patentable.

GROUP X. Claim 21 is separately patentable.

GROUP XI. Claim 22 is separately patentable.

GROUP XII. Claim 24 is separately patentable.

The basis upon which these groups and claims are separately patentable is set forth in the argument section of the brief.

VIII. ARGUMENT

Claims 18-22 and 24 are remaining in this application.

ISSUE I. WHETHER CLAIMS 8 AND 21 HAVE BEEN PROPEERLY REJECTED UNDER 35 USC 112, FIRST PARAGRAPH, FOR FAILING TO COMPLY WITH THE WRITTEN DESCRIPTION REQUIREMENT

Claim 8 and 21 were rejected under 35 USC 112, first paragraph, as failing to comply with the written description requirement. The Examiner has taken the position that in claim 8 and 21 the recitation “and so that the etching does not stop on the low dielectric constant material and the dielectric layer is etched” raises new matter, which lacks support from the Specification. The rejection is in error and Appellants respectfully request the Board to reverse the rejection.

THE NEGATIVE LIMITATION IS ACTUALLY IN APPELLANTS’ SPECIFICATION

The Board’s attention is directed to the instant application at the last paragraph, bridging pages 16 and 17, wherein Appellants provide comparative examples of the present invention to the prior art. In the examples, a semiconductor device having eight levels of copper metal interconnect and an interlayer dielectric of $\text{Si}(\text{CH}_3)_x\text{O}_{2-x}$ was sectioned and etched with a solution prepared according to the present invention, including an aqueous solution of HF and HCl. The etched device was analyzed under a scanning electron microscope and all eight levels of copper and dielectric layer were clearly visible. In contrast, as described on page 17, when a similar device was sectioned and etched with a prior art aqueous solution including HCl, the “etch stopped on the low dielectric constant material.” Appellants’ recites substantially the same language in independent claims 8 and 21.

Appellants having described the prior art in their application, are entitled to exclude the prior art in their claims using negative limitations. There is no rule, or law, per se against the use of negative limitations. Ex parte Allwelt, 105 USPQ 133 (BOPAI 1954). The Examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a prima facie case of unpatentability. In re Oetiker, 977 F.2d 1443 (Fed. Cir. 1992). The specification as a whole, including the examples therein, reasonably conveys to a person of ordinary skill in the art that the inventors had possession of the subject matter (negative limitations) in question at the time the present application was filed. Ex parte Park, 30 USPQ2d 1234, 1236 (BPAI 1994). To date, the Examiner has not proffered or pointed to any factual evidence to the contrary. Appellants request the reversal of the rejection of claims 8 and 21 under 35 USC 112.

ISSUE II. WHETHER CLAIMS 8, 12, 13, 14, 18 AND 20 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER

Claims 8, 12, 13, 14, 18 and 20 have been properly rejected under 35 USC103(a) as being unpatentable over Buynoski in view of Weber. The rejection is in error for the following reasons.

WEBER AND BUYNOSKI FAIL TO DISCLOSE THE CLAIMED INVENTION, AND ACTUALLY TEACH AWAY FROM THE CLAIMED INVENTION

The Examiner maintains that Buynoski teaches providing a semiconductor device having at least two metal interconnect layers having low dielectric constant material between the metal interconnect layers citing column 5, lines 45-59 in Figs. 1-4. The Examiner acknowledges that

Buynoski does not teach etching the device with an aqueous solution of HF and HCl (See page 3 of the final Office Action of July 30, 2003).

The Examiner maintains that Weber teaches that HCl and HCl tend to preferentially etch the interface region between a metal electrode and a substrate such as a polyamide (in maintaining that the polyamide is a low dielectric constant material) citing columns 4, lines 21-24, and maintains that Weber reads on etching a semiconductor device in the aqueous solution of HCl and HF.

However, the Examiner's reading and interpretation of Weber is erroneous, which makes the rejection fatally defective. The Weber teaches anodically etching a metal layer using electrolytes solution including ammonium hydroxide. All of the examples in Weber are directed to this invention. The only exception is the one paragraph cited by the Examiner. However, the Board's attention is respectfully directed to column 4, lines 17-28. Weber states: "Hydrochloric and hydrofluoric acid are volatile electrolytes which are incompatible for use in some applications of the subject invention." Weber states that each of hydrochloric and hydrofluoric are volatile electrolytes. Weber does not teach etching with an aqueous solution of hydrochloric acid and hydrofluoric acid. The Weber states: "hydrochloric acid and hydrofluoric acid tend to preferentially etch the interface region between a metal electrode and a substrate such as polyamide." It is unclear what the "interface region" between the metal electrode and the substrate is, nor is it clear what exactly is etched. Those skilled in the art are left to speculate as to what is actually is etched. Obviousness cannot be predicated on speculation. What is clear, however, is that Weber does not disclose etching a low dielectric constant material with an aqueous solution of hydrochloric acid and hydrofluoric acid. Nor does Weber teach etching a

low dielectric constant material between two metal interconnect layers has called for in claim 8. Applicant maintains that Weber does not teach etching the polyamide layer. At best, even if one would strain to interpret Weber as disclosing etching the polyimide layer, the etching process clearly stops on the polyamide layer. Independent claim 8 as now amended clearly distinguishes over even a strained and speculative interpretation of the disclosure of Weber. Furthermore, since claim 8 is not anticipated under 35 USC 102, Appellants point out the teaching away comments regarding “crazing” made in column 4, lines 26-28. A person of ordinary skill in the art would not be motivated to combine or modify Buynoski in view of Weber in the face of these teaching away comments.

Although Buynoski may teach two metal interconnect layers with a low dielectric constant material therebetween, one cannot ignore the teaching away effect set forth in the paragraph bridging columns 4 and 5, which discloses that a low dielectric constant material (BCB) should be etched with a mixed oxygen-fluorine plasma. As such, Buynoski actually teaches away from etching a low dielectric material with an aqueous solution of hydrochloric acid and hydrofluoric acid. There’s no motivation in any of the references to modify Weber or Buynoski to arrive at applicants claimed invention, nor is there any teaching in the prior art to provide a person of ordinary skill in the art with a reasonable expectation of success if such modification were made. Appellants respectfully request to Board to reverse the Examiner’s rejection.

ISSUE III. WHETHER CLAIMS 9 and 17 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE AND FURTHER IN VIEW OF ASAM

Claims 9 and 17 have been rejected under 35 USC 103 is being unpatentable over Buynoski in view of Weber applied to claim 8 above, and further in view of Asam. The rejection is in error for the following reasons.

ASAM DOES NOT POINT OUT WHICH IS THE “RESULT EFFECT VARIABLE”

Appellants’ above comments regarding Buynoski and Weber are hereby repeated. The Examiner maintains that Asam teaches the etching step may be controlled by regulating etchant concentration. However, since Weber fails to disclose Appellants’ claimed etching solution comprising an aqueous solution of HCl and HF, the references do not identify which of the multiple possible variables is the “result effective variable” to be optimized. Furthermore, the teaching away effects of the numerous references of record cannot be overlooked in hindsight to identify a “result effective variable” and simply conclude that optimization thereof would have been within the skill of a person in the art.

ISSUE IV. WHETHER CLAIMS 10, 11, 15, 19 and 22 HAVE BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF TOBBEN ET AL

Claims 10, 11, 15, 19 and 22 had been rejected under 35 USC 103 is being unpatentable over Buynoski in view of Weber as applied to claim 8 above, and further in view of Tobben et al. The rejection is in error for the following reason and should be reversed.

THE REJECTION FAILS TO IDENTIFY SUFFICIENT MOTIVATION TO SUBSTITUTE DIFFERENT DIELECTRIC LAYERS, AND TOBBEN ET AL TEACH AWAY FROM THE CLAIMED INVENTION

Appellants comments above regarding Buynoski and Weber are hereby repeated. The Examiner has taken the position that it would have been obvious to modify Buynoski with the methyl silsesquioxane disclosed in Tobben. However, Tobben teaches etching the dielectric layer 112 with a conventional reactive ion etching process, see column 4, lines 48-15. Even if there is motivation to substitute dielectric layers, a person of ordinary skill in the art would not ignore the teaching away statements of Tobben with regard to etching techniques.

ISSUE V. WHETHER CLAIM 16 HAS BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF GARDNER

Claim 16 had been rejected under 35 USC 103 as being unpatentable over Buynoski in view of Weber as applied to claim 8 and further in view of Gardner. The rejection is in error for the following reasons and should be reversed.

GARDNER DOES NOT OVERCOME THE DEFICIENCIES OR TEACHING AWAY EFFECT OF THE OTHER REFERENCES

Appellants comments above regarding Buynoski and Weber are hereby repeated. Although Gardner teaches a variety of low dielectric layers, the addition of this reference cannot overcome the deficiencies of Weber and the teaching away effects of numerous references relied on by the Examiner.

ISSUE VI. WHETHER CLAIM 21 HAS BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS BEING UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER

Independent claim 21 recites “and so that the etching does not stop on the low dielectric constant material and the dielectric layer is etched” in a manner similar to claim 8 and is patentable for the same reasons stated above. Claim 21, by requiring that the etching does not stop on the low dielectric constant material and the dielectric layer is etched, defines over Weber that teaches an etching solution that stops on the dielectric layer. The rejection is in error and should be reversed.

ISSUE VII. WHETHER CLAIM 24 HAS BEEN PROPERLY REJECTED UNDER 35 USC 103(a) AS UNPATENTABLE OVER BUYNOSKI IN VIEW OF WEBER AS APPLIED TO CLAIM 8 ABOVE, AND FURTHER IN VIEW OF LEE ET AL

Claim 24 had been rejected under 35 USC 103(a) as unpatentable over Buynoski in view of Weber as applied to claim 8 above, and further in view of Lee et al. The rejection is in error and should be reversed for the following reasons.

LEE, ET AL. FAILS TO DISCLOSE THE USE OF A LOW DIELECTRIC CONSTANT DIELECTRIC LAYER AND THE PROBLEM ASSOCIATED WITH PREPARING A SPECIMEN THEREOF FOR VIEW UNDER A SCANNING ELECTRON MICROSCOPE

Lee, et al. U.S. Patent No.6,251,782 discloses a method of preparing a specimen by focused ion beam sectioning for examination under an electron-scanning microscope. The Examiner has focused on Lee, et al. at column 2, lines 52-54, which discloses that “the structure is then etched in a wet etchant such that it may be observed in an SEM for studying the characteristic feature or defect and its reason for being defective.” However, Lee, et al. fails to disclose the use of a low dielectric constant dielectric layer and the problem associated with preparing a specimen thereof for view under a scanning electron microscope. In fact, Lee, et al. fails to disclose any specific etchant for use on the dielectric layer (which is an oxide insulating

layer 44 (see col.6, lines 6-8)). The Board's attention is respectfully directed to the paragraph bridging columns 6 and 7 which states at line 67, that "a suitable wet etchant can be used to etch away the insulating layer, i.e., the oxide layer such that a failed bit of the polished silicon gate and floating gate can be shown." As such, Lee, et al. fails to address the problem of preparing a specimen having a low dielectric layer and analyzing the etched device in a scanning electron microscope as now called for in Appellants claim 24. The Board should reverse the Examiner's rejection of claim 24.

SEPARATE PATENTABILITY

GROUP I: Claims 8, 12-14, 16 stand and fall together in this appeal. The claims of Group I are patentable for the reasons stated above.

GROUP II. Claim 9 is separately patentable. Claim 9 is separately patentable because the prior art does not suggest the recited weight ratio of HF to HCl.

GROUP III. Claim 10 is separately patentable. Claim 10 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material includes -OR groups.

GROUP IV. Claim 11 is separately patentable. Claim 11 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material includes methyloxy groups.

GROUP V. Claim 15 is separately patentable. Claim 15 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material has a dielectric constant less than 3.8.

GROUP VI. Claim 17 is separately patentable. Claim 17 is separately patentable because the prior art does not suggest the recited deionized water and weight ratio of HF to HCl.

GROUP VII. Claim 18 is separately patentable. Claim 18 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material is hydrophobic.

GROUP VIII. Claim 19 is separately patentable. Claim 19 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material includes an organosilicon.

GROUP IX. Claim 20 is separately patentable. Claim 20 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material includes an organic based film.

GROUP X. Claim 21 is separately patentable for the reasons stated above.

GROUP XI. Claim 22 is separately patentable. Claim 22 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the low dielectric constant material includes $\text{Si}(\text{CH}_3)_x\text{O}_{2-x}$.

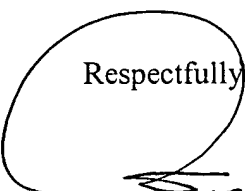
GROUP XII. Claim 24 is separately patentable. Claim 24 is separately patentable because the prior art does not suggest etching a semiconductor device with an aqueous solution of HF and HCl wherein the device includes a low dielectric constant material, and analyzing the device in a scanning electron microscope. The prior art does not suggest that the individual layers of a device so etched would be visible under a scanning electron microscope.

IX. CONCLUSION

Claims 18-22 and 24 are remaining in this application. The Examiner's rejection of the claims is in error and should be reversed. The negative limitations used in claims 8 and 21 actually are in Appellants' specification. Weber teaches etch with ammonium hydroxide and does not disclose an aqueous etching solution of HF and HCL. Instead Weber actual teaches that an etching solution of HF or HCl will stop on a low dielectric constant layer. Buynoski teaches away by teaching to etch with mixed oxygen-fluorine plasma. Asam does not identify the "result effect variable" to optimize. The rejection does identify sufficient motivation to substitute dielectric layer of Tobben for that of Buynoski. Tobben also teaches away by etching with a with a conventional reactive ion etching process. Gardner does not overcome the deficiencies or teaching away of the other references. Lee, et al. fails to disclose the use of a low dielectric constant dielectric layer and the problem associated with preparing a specimen thereof for view under a scanning electron microscope.

In view of the above errors in the rejections and Appellants' arguments, Appellants respectfully request that the Board reverse the Examiners' rejection of the claims remaining in the case.

Respectfully submitted



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LIST OF CLAIMS INVOLVED IN THE APPEAL

Claims 1. - 7. (Cancelled)

Claim 8: A method comprising:

providing a semiconductor device having at least two metal interconnect layers and a dielectric layer comprising a low dielectric constant material between the metal interconnect layers;

etching the device in aqueous solution of HF and HCl and so that the etching does not stop on the low dielectric constant material and the dielectric layer is etched.

Claim 9: A method as set forth in claim 8 wherein the weight ratio of HF to HCl in the solution ranges from 1:3 to 4:1.

Claim 10: A method as set forth in claim 8 wherein the low dielectric constant material includes -OR groups wherein R is a hydrocarbon derivative.

Claim 11: A method as set forth in claim 8 wherein the low dielectric constant includes methyloxy groups.

Claim 12: A method as set forth in claim 8 wherein the metal interconnect consists essentially of copper.

Claim 13: A method as set forth in claim 8 wherein the metal interconnect comprises aluminum.

Claim 14: A method as set forth in claim 8 wherein the step of etching the device is carried out by dipping the device in a bath of the aqueous solution of HF and HCl.

Claim 15: A method as set forth in claim 8 wherein the low dielectric constant material has a dielectric constant less than 3.8.

Claim 16: A method as set forth in claim 8 wherein the low dielectric constant material comprises fluorosilicate glass.

Claim 17: A method as set forth in claim 9 wherein the aqueous solution includes deionized water and wherein the weight ratio of the deionized water to either HF or HCl ranges from about 20:1 to 6:5.

Claim 18: A method as set forth in claim 8 wherein the low dielectric constant material is hydrophobic.

Claim 19: A method as set forth in claim 8 wherein the low dielectric constant material comprises an organosilicon.

Claim 20: A method as set forth in claim 8 wherein the low dielectric constant material comprises an organic based film.

Claim 21: A method comprising:

providing a semiconductor device having at least two metal interconnect layers and a dielectric layer comprising a low dielectric constant material between the two metal interconnect layers;

etching the semiconductor device in an aqueous solution of HF and HCl and so that the etching does not stop on the low dielectric constant material and the dielectric layer is etched.

Claim 22: A method as set forth in claim 8 wherein the low dielectric constant material includes $\text{Si}(\text{CH}_3)_x\text{O}_{2-x}$.

Claim 23. (cancelled)

Claim 24: A method as set forth in claim 8 further comprising analyzing the etched device in a scanning electron microscope.